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PATENT SPECIFICATION

627,295

Application Date: April 10, 1946. No. 11069/46.

Complete Specification Left: Feb. 4, 1947.

Complete Specification Accepted: Aug. 5, 1949.

Index at acceptance:—Classes 83(ii), A166; 83(iii), K(1e:3i5:3u:7c:7g:8), W7a2; and 110(iii), B2b(2:3).

PROVISIONAL SPECIFICATION

Improvements in or relating to the Manufacture of Guide Vanes for Axial-Flow Turbines and Compressors

We, ADRIAN ALBERT LOMBARD, a British Subject, of Millthorne House, Clitheroe, Lancashire, and WALTER [illegible] British Subject, of

applicable when the vanes are formed as forgings to the final vane configuration or as forgings or castings and finished by machining. It will be seen that the

ERRATUM

SPECIFICATION No. 627,295.

Page 4, line 17, *after* " vanes " *insert* " define "

THE PATENT OFFICE,
7th November, 1949.

locating the vane proper at three points one of which lies on a line defining the theoretical throat on one side of the vane and the other two of which lie on a line defining the theoretical throat on the other side of the vane, and machining the locating means on the vane while it is so located. One such line is the trailing edge of the blade and the other is a line on its convex face that would be opposite the trailing edge of the next vane when the two vanes are correctly assembled together. It is preferred that the vane should be located by its trailing edge and a single point on its convex face.

The present invention is particularly applicable when the vanes are formed as precision castings so that the vanes proper require no machining but it is also and forms an abutment against which the convex face of the vane is held by a screw projecting from the other side of the slot opposite the abutment. The screw engages the vane through a cap freely rotatable on the screw. A pair of jaws are mounted on one side of the slot so that they overlie the leading edge of the vane and are adjustable to engage the leading edge and clamp the vane in the slot.

The present method is particularly applicable to the manufacture of vanes which are mounted in the manner described in the Specification of the copending British Patent Application No. 10630/46 (Serial No. 611,326) by means of tablets at each end of the vanes or of lands on such tablets. Each tablet is a parallelogram in plan and each land, if

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PROVISIONAL SPECIFICATION

Improvements in or relating to the Manufacture of Guide Vanes for Axial-Flow Turbines and Compressors

We, ADRIAN ALBERT LOMBARD, a British Subject, of Millthorne House, Clitheroe, Lancashire, and WALTER EDWARD DAZELEY, a British Subject, of Clough Head, Twiston, near Clitheroe, Lancashire, do hereby declare the nature of this invention to be as follows:—

This invention relates to the manufacture of guide vanes for axial-flow turbines and compressors. The throat area of the nozzle guide vanes (that is the area between the trailing edge of each vane and the adjacent vane on its concave side) of an internal-combustion turbine is a critical area controlling the work output of the turbine and depends not only on the shape of the vanes but also on the angle at which each vane is set to a radial plane through the turbine axis. The vanes are normally mounted in inner and outer rings and it is essential, therefore, that the means on the vanes for locating them in the rings should be correctly located on them.

According to the present invention a method of manufacturing a guide vane comprises the steps of first shaping the vane proper to its final configuration locating the vane proper at three points one of which lies on a line defining the theoretical throat on one side of the vane and the other two of which lie on a line defining the theoretical throat on the other side of the vane, and machining the locating means on the vane while it is so located. One such line is the trailing edge of the blade and the other is a line on its convex face that would be opposite the trailing edge of the next vane when the two vanes are correctly assembled together. It is preferred that the vane should be located by its trailing edge and a single point on its convex face.

The present invention is particularly applicable when the vanes are formed as precision castings so that the vanes proper require no machining but it is also applicable when the vanes are formed as forgings to the final vane configuration or as forgings or castings and finished by machining. It will be seen that the present invention ensures that the locating means on the vanes shall be correctly machined with reference to a plane through the two lines that define the theoretical throat between the assembled vanes so that when the vanes are assembled, the correct throat area will be obtained.

The present invention also includes a jig for locating the vane and comprising means whereby the vane is located along one edge to pivot thereabout an abutment to engage the convex face of the vane at a predetermined point and means for holding the blade against the abutment.

In one construction the jig comprises a block formed with a slot to accommodate the vane with its ends projecting from the slot. A V-shaped groove is formed in the bottom of the slot and the trailing edge of the vane is received in this groove so that the blade can pivot about this edge. A pin with a rounded head is mounted in a hole in one side of the slot and forms an abutment against which the convex face of the vane is held by a screw projecting from the other side of the slot opposite the abutment. The screw engages the vane through a cap freely rotatable on the screw. A pair of jaws are mounted on one side of the slot so that they overlie the leading edge of the vane and are adjustable to engage the leading edge and clamp the vane in the slot.

The present method is particularly applicable to the manufacture of vanes which are mounted in the manner described in the Specification of the copending British Patent Application No. 10630/46 (Serial No. 611,326) by means of tablets at each end of the vanes or of lands on such tablets. Each tablet is a parallelogram in plan and each land, if

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provided, is parallel to the side of the tablets .For this purpose the sides of the block of the jig may make the same angles to one another as the side and ends of the tablet at one end of the vanes with the slot cut at the correct angle to its sides. The jig can then be mounted in a holder or cradle with one side uppermost to allow of the uppermost side of on tablet or land to be machined. The jig can then be remounted with another side uppermost and another side of the tablet or land machined. The ends of the two tablets will usually be parallel so that the same jig can be used for machining the ends of both tablets. The sides of one tablet will not be parallel to those of the other, so that a different jig holder or cradle may be required when the sides of one tablet are machined.

Dated this 10th day of April, 1946.
BOULT, WADE & TENNANT,
111 & 112, Hatton Garden,
London, E.C.1,
Chartered Patent Agents.

COMPLETE SPECIFICATION

Improvements in or relating to the Manufacture of Guide Vanes for Axial-Flow Turbines and Compressors

We, ADRIAN ALBERT LOMBARD, a British Subject, of Millthorne House, Clitheroe, Lancashire, and WALTER EDWARD DAZELEY, a British Subject, of Clough Head, Twiston, near Clitheroe, Lancashire, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

This invention relates to the manufacture of guide vanes for axial-flow turbines and compressors. The throat area of the nozzle guide vanes (that is the area between the trailing edge of each vane and the adjacent vane on its concave side) of an internal combustion turbine is a critical area controlling the work output of the turbine and depends not only on the shape of the vanes but also on the angle at which each vane is set to a radial plane through the turbine axis. The vanes are normally mounted in inner and outer rings and it is essential, therefore, that the means on the vanes for locating them in the rings should be correctly located on them.

According to the present invention a repetition method of manufacturing a guide vane comprises the steps of first shaping the vane proper to its final configuration, supporting the vane in a jig which engages the vane proper at points or lines which in the final assembly of vanes define the theoretical throat area measured between adjacent vanes and machining the locating means on the vane while is is so supported. One such location may be at points or along a line at the trailing edge of the blade and another engagement is at a point or line on its convex face that would be opposite the trailing edge of the next vane when the two vanes are correctly assembled together. It is preferred that the vane should be located by its trailing edge and a single point on its convex face.

The present invention is particularly applicable when the vanes are formed as precision castings so that the vanes proper require no machining but it is also applicable when the vanes are formed as forgings to the final vane configuration or as forgings or castings and finished by machining. It will be seen that the present invention ensures that the locating means on the vanes shall be correctly machined with reference to a plane through the two lines that define the theoretical throat between the assembled vanes so that when the vanes are assembled, the correct throat area will be obtained.

The present invention also includes a jig for locating the vane and comprising means whereby the vane is located along one edge to pivot thereabout, an abutment to engage the convex face of the vane at a predetermined point and means for holding the blade against the abutment.

A practical application of this invention will now be described, by way of example, with reference to the accompanying drawings whereof:—

Figure 1 is a side view of a nozzle guide vane which is manufactured in accordance with the present invention;

Figure 2 is a view in the direction of arrow 2 of Figure 1;

Figure 3 is a diagrammatic development view showing the relative disposition of the vanes when mounted in position in the turbine;

Figure 4 is an end view of a jig for locating the vane of Figures 1 and 2 whilst it is being machined and also of a support for the jig;

Figures 5 and 6 are views of the jig as seen respectively in the direction of arrows 5 and 6 of Figure 4; and

Figure 7 is a part view of a milling machine with the jig of Figure 4 mounted thereon.

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The present method is particularly applicable to the manufacture of vanes as shown in Figures 1 and 2 which comprise a vane portion proper—generally indicated at 10—and a pair of tablets 11 and 12. The vane is of aerofoil section (Figure 2) and is formed with a straight leading edge 13 and straight trailing edge 14. Each tablet 11 and 12 is a parallelogram in plan and has its front and rear edges 11*a*, 12*a* and 11*b*, 12*b* in line with one another whilst the front edges are parallel with the rear edges.

The guide vanes are mounted in the manner described in the Specification to Application 10630 (Serial No. 611,326) the tablets 11 and 12 being located in inner and outer rings so that part 10 lies generally radially of the rings and between them. When so mounted, a development view showing the parts 10 of adjacent vanes in section is as in Figure 3.

The throat area of the guide vanes is determined by the distance *x* between the trailing edge 14 of each vane and the nearest point 15 to the trailing edge on the convex side 16 of the next adjacent vane. This area decides the work output of the turbine so that the distance *x* requires to be accurate—this, in turn, will be determined by the degree of accuracy with which the tablets 11 and 12 are mounted in the rings referred to. Finally, the method of machining the faces of the tablets which locate them in position in the rings will decide the distance *x*. This invention is directed to machining the tablets whilst the vanes are located by those parts of it which define the distance *x*—and hence the throat area. The parts are the trailing edge 14 and the point 15 at a certain determined position along the length of the vane (Figure 1).

To effect the location referred to the vane is mounted for machining in the jig of Figures 4 to 6. Turning to these figures: the jig comprises a block 17 formed with an opening 18 to accomodate the vane with its tablets 11 and 12 projecting from the opening. A **V**-shaped groove 19 is formed at the bottom of opening 18 and trailing edge 14 of the vane is received in this groove so that the blade is free to pivot about this edge. A pin 20 with a rounded head is mounted part-way up one side of opening 18. The pin forms an abutment against which the convex face 16 of the vane is held by a screw 21. The screw 21 engages the vane by a cap 22 freely rotatable on the screw.

The points of engagement of pin 20 and cap 22 chordwise of the vane are determined by their location above groove 19. To determine their engagement lengthwise of the vane, the block carries at each side a stop 23 which is adjusted to engage the inner faces of the tablets 11 and 12 and positively locate the vane lengthwise of the jig. It is arranged that pin 20 engages face 16 at point 15.

The axes of pins 20 and 22 are relatively displaced in a manner which causes the edge 14 to bear against one side of groove 19 when screw 21 is tightened.

A pair of jaws 24 are carried on one side of opening 18 so that they overlie the leading edge 13 of the vane and are adjustable by nuts 25 to engage the edge and clamp the vane against groove 19 within opening 18. The surfaces of the block 17 shown in the drawing make the same angles to one another as the edges of tablet 11.

When a vane, with part 10 in its finished state, is mounted in the jig the top and bottom surfaces 26, 27 repectively are parallel to the front and rear edges 11*a*, 11*b* of tablet 11 (Figure 4): these surfaces are, therefore, also parallel to the front and rear edges 12*a*, 12*b* of tablet 12.

Furthermore, the side edges of tablet 11 are parallel to surfaces 28 of block 17 but, of course, not to the corresponding side edges of table 12.

The jig is carried by a base 29 which is, in turn, mounted on the table 30 of, say a horizontal milling machine 31 (Figure 7). When the table 30 moves past the cutter 32, edge 11*a* of tablet 11 is machined. The jig is mounted in base 29 with surfaces 26, 27 horizontal so that the machined edge 11*a* will be horizontal.

It is preferred to have a pair of spaced cutters 32 simultaneously to machine edges 11*a* and 12*a* of tablets 11 and 12.

When so machined the jig is remounted on base 29 with edges 11*b* and 12*b* uppermost and these are similarly machined. Then the base 29 is changed for a new base (not shown) and the jig is laid with its side surfaces on this new base so that the side edges of tablet 11 may be similarly machined. Thus, the vane is located in the jig by edge 14 and point 15 and then has one tablet (11) completely machined and the front and rear edges of the other tablet (12) machined without removal of the vane from the jig.

The vane is then mounted is a similarly constructed jig so arranged, however, that the side edges of tablet 12 are parallel with the side surfaces 28 of block 17—these edges are then machined.

As shown in Figure 4, the base 29 is arranged to accommodate, at the same

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time, two jigs. In this way the edges of 11*a*, 12*a* of one vane may be machined simultaneously with edges 11*b*, 12*b* of another vane, the vanes being mounted side by side in the pair of jigs.

Having now particularly described and ascertained the nature of our said invention and in what manner the same is to be performed, we declare that what we claim is:—

1. A repetition method of manufacturing a guide vane comprising the steps of first shaping the vane proper to its final configuration, supporting the vane in a jig which engages the vane proper at points or lines which in the final assembly of vanes the theoretical throat area measured between adjacent vanes and machining the locating means on the vane while it is so supported.

2. A repetition method of manufacturing a guide vane according to claim 1 wherein one such jig engagement is at points or along a line at the trailing edge of the blade and another engagement is at a point or line on its convex face that would be opposite the trailing edge of the next vane when the two vanes are correctly assembled together.

3. A repetition method of manufacturing a guide vane according to claim 2 in which the vane is located by its trailing edge and a single point on its convex face.

4. A repetition method of manufacturing a guide vane wherein locating means at each end of the vane proper is simultaneously machined in accordance with any preceding claim.

5. Apparatus for carrying out the repetition method of manufacturing a guide vane according to any preceding claim comprising a jig for locating the vane and having means whereby the vane is located along one edge to pivot thereabout, an abutment to engage the convex face of the vane at a predetermined point and means for holding the blade against the abutment.

6. Apparatus as claimed in claim 5 comprising a V-shaped groove to be engaged by the trailing edge of the blade and a pin to be engaged by the convex face of the blade.

7. Apparatus as claimed in claim 6 wherein means are provided to engage the leading edge of the blade and clamp the latter in the jig and against the groove and pin.

8. Apparatus as claimed in claim 7 wherein a screw is provided to engage the concave side of the vane and maintain it against the pin.

9. A repetition method of manufacturing a guide vane according to claim 1 substantially as hereinbefore described with reference to the accompanying drawings.

Dated this 4th day of February, 1947.
BOULT, WADE & TENNANT,
111 & 112, Hatton Garden,
London E.C.1,
Chartered Patent Agents.

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627,295 COMPLETE SPECIFICATION

SHEE

Fig.2.

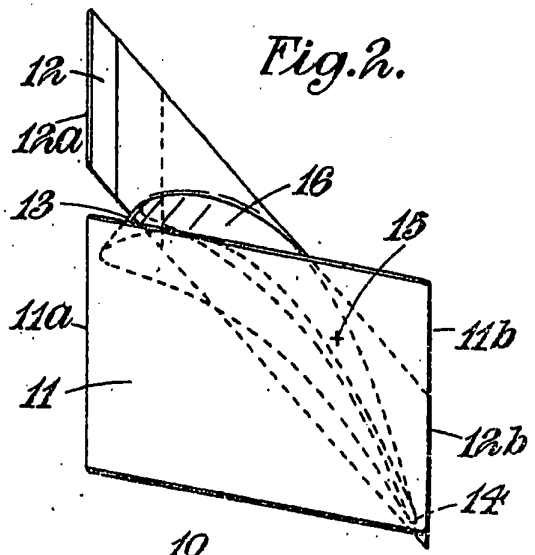


Fig.3.

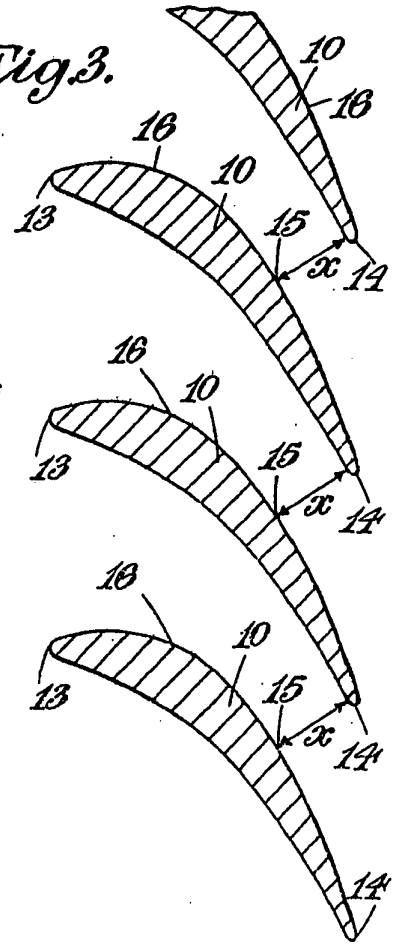
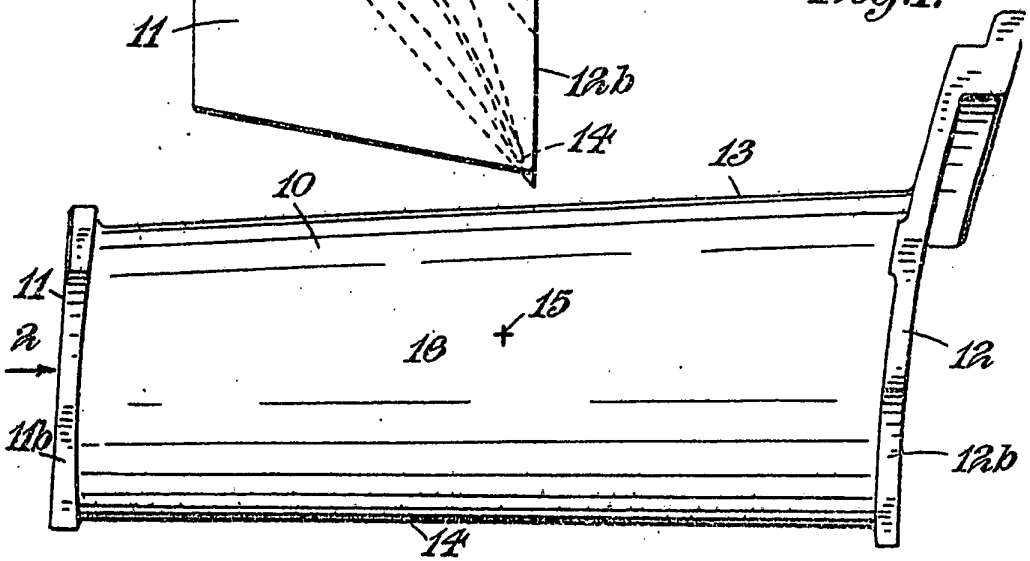


Fig.1.



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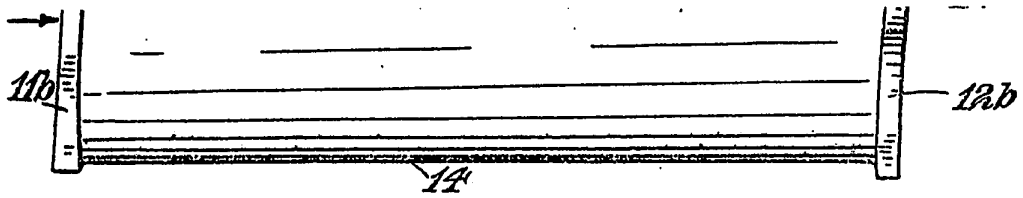

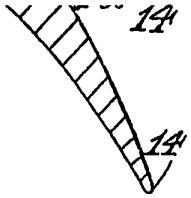

SHEET 1

Fig.3.

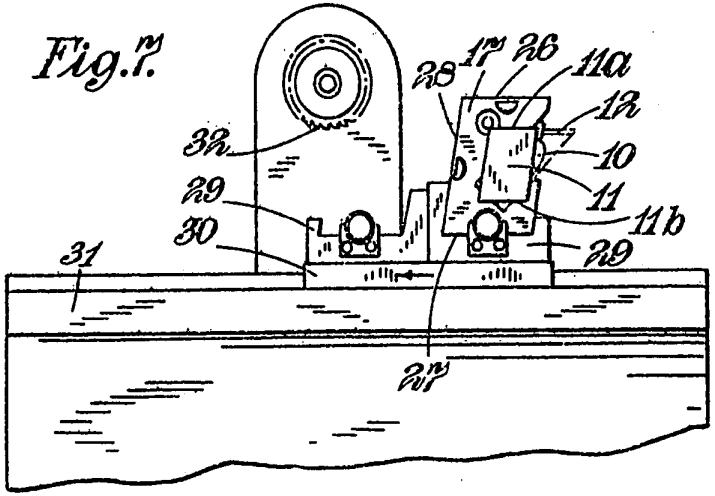

Fig.4.

3 SHEETS
SHEET 2

H.M.S.O.(Ty.P.)

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627,295 COMPLETE SPECIFICATION

SHEET 1

Fig.2.

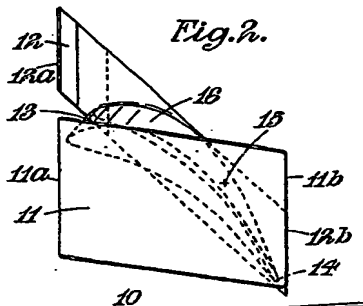


Fig.3.

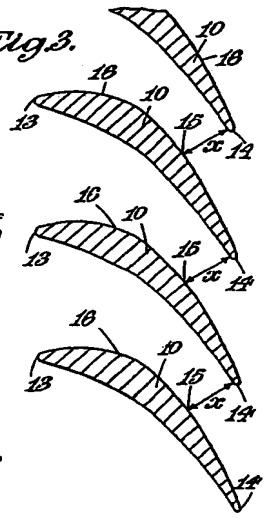


Fig.1.

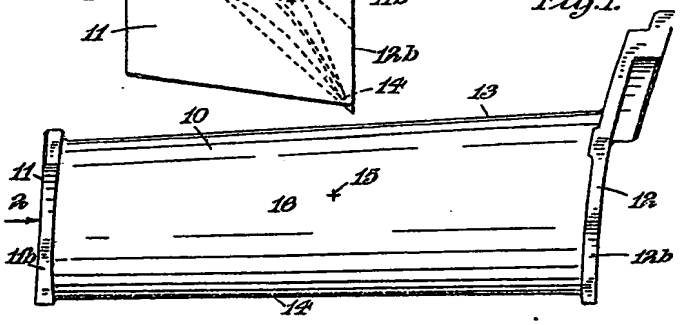


Fig.7.

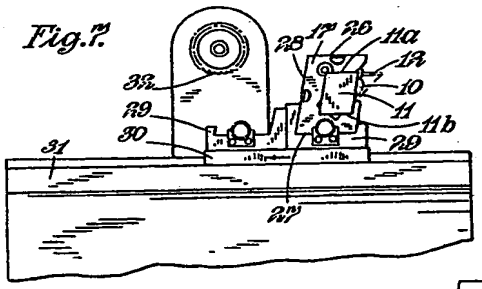


Fig.4.

SHEET 2

J SHEETS

H.M.S.O.(T.P.)

[This Drawing is a reproduction of the Original on a reduced scale.]

Fig.5.

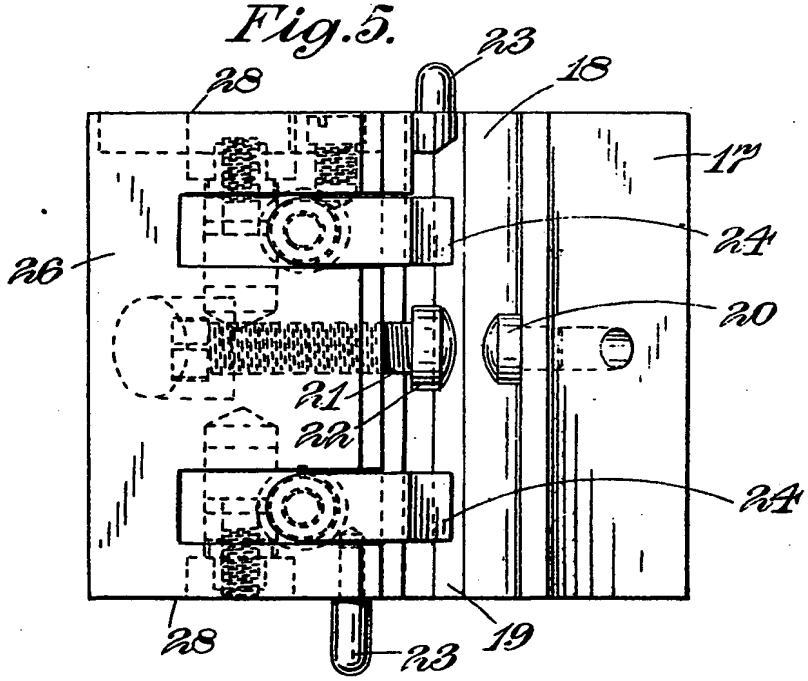
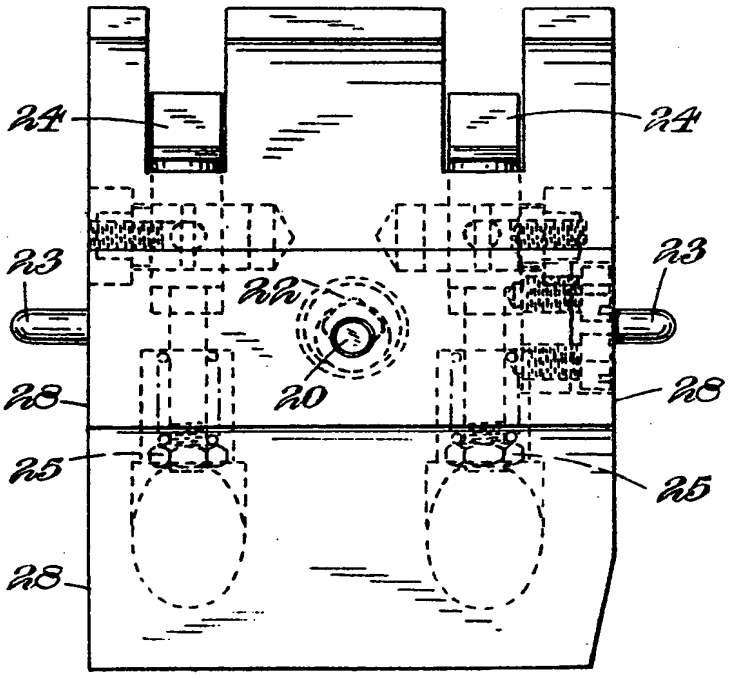


Fig.6.



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